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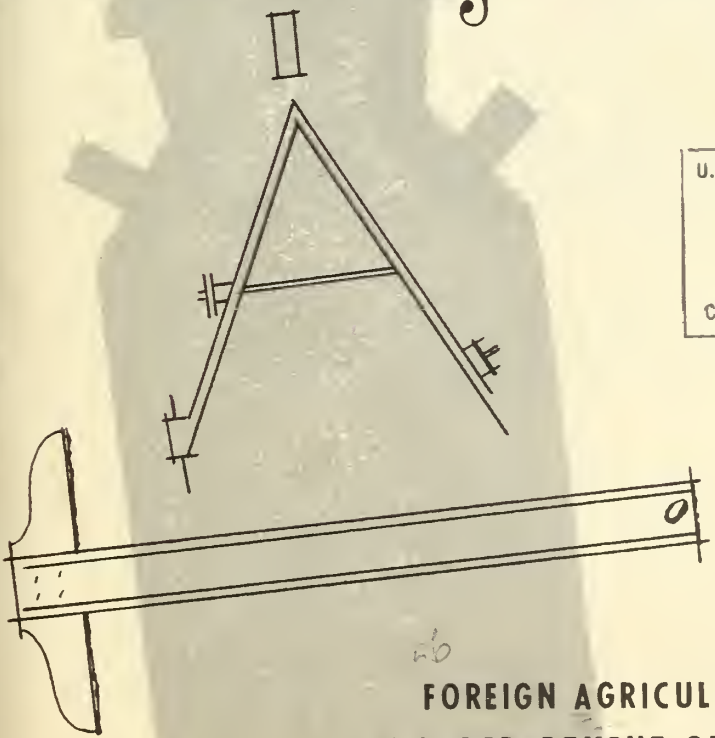
Planning and Equipping the Milk Recombining Plant



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This publication is the last in a series of four issued by the Foreign Agricultural Service on how recombining can be used to create a supply of fluid milk and manufactured dairy products, including canned milk, in countries where the milk supply is inadequate to meet demand. The first three were: Foreign Agriculture Report No. 84, Recombined Milk, slightly revised November 1955: Technical report on establishing of plants for production of recombined fluid milk from the recombining ingredients low heat, spray process, nonfat dry milk, and anhydrous milk fat. FAS-M-21, How To Use Recombined Milk Ingredients in Manufacturing Dairy Products, issued in 1957. FAS-M-66, Recombined Condensed Milk, Recombined Sterilized Milk, Toned Milk, issued November 1959.

PLANNING AND EQUIPPING THE MILK RECOMBINING PLANT

By L. H. Burgwald and D. R. Strobel*

INTRODUCTION

In planning a milk-recombining plant, first determine as nearly as possible the type and size of equipment desired, and then build the plant to house it. Some latitude must be provided to meet future expansion.

Arrangement of equipment should be such that the pattern of product flow and of material handling will be efficient. Usually "straight line" or "U" flow is most effective. By laying out the proposed floor plan on graph paper and making templates of the equipment, several tentative arrangements of the equipment can be shown.

SIZE OF PLANT AND AREAS NEEDED FOR VARIOUS ROOMS

Information available indicates that a plant requires, on an average, approximately 1 square foot of floor space per gallon of milk processed.[1] The processing room must be large enough to provide ample space for cleaning the equipment and for future expansion. Equipment should not occupy more than 30 percent of the floor space,[2] and some experts state that 20 percent is preferable.[3]

A good figure for dry storage area is reported to be about 25 percent of the total plant area.[3] However, nearness to supplies and amount of materials needed to be stocked are factors.

The milk cold storage room requires about 1 square foot of floor space for every 7.5 to 9.0 gallons of milk handled.[1] The bottle washing and bottle storage room should be large enough to accommodate the equipment plus an area equal to that of the cold storage room.[3]

The ice cream hardening room, according to one estimate,[3] should be large enough to hold at least 5 days of maximum production. (Maximum daily production is frequently figured as 1.0 percent of total yearly production.) Another method of figuring required size of this room involves use of the formula, $P \times 0.01 \times \frac{3}{F}$. (P = the

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[1]Research Digest, Oct. 15, 1959, Dairy Technology Extension, Ohio State University, Columbus, Ohio.

[2]"Dairy Plant Management," by Tracy, Armerding, & Hannah. McGraw-Hill, New York, 1958.

[3]Research Digest, Dec. 15, 1959, Dairy Technology Extension, Ohio State University, Columbus, Ohio.

production for year; F = the number of gallons used, depending on percentage of production put up in packages or novelties and percentage put up in bulk:[4])

1 sq. ft. required for--	Percentage in-- Packages and novelties	Bulk
	Percent	Percent
12 gallons	75	25
14 gallons	50	50
16 gallons	25	75
20 gallons	--	100

UTILITIES AND LABOR REQUIREMENTS[1]

About 1 pound of steam (970 B.t.u.) and 8.3 pounds of water are required for every gallon of milk processed.

Approximately 160 horse-power hours of electricity per 1,000 gallons of milk processed is required (1 hp. = 0.746 kw.).

Plant expenses in the United States amount to about $1.65 per 100 pounds of milk processed, and labor costs constitute approximately 29 percent of this figure. Efficient milk plants with a daily capacity of 1,200 to 56,000 gallons require about one man-day per 500 - 600 gallons processed.

PLANT CAPACITY

A relatively small plant for recombining will handle 400 gallons of product per hour, or approximately 2,000 gallons of milk and 400 gallons of ice cream mix in an 8-hour day. This is about 6 hours of processing and about 2 hours of cleanup. The smallest practical size for a plant is one that handles 200 gallons of milk and 40 gallons of ice cream per day.

EQUIPMENT, SIZE, COST, AND FLOOR SPACE

For such plants the necessary equipment, the space required for it, and approximate cost, f.o.b. U.S. factory, are as follows:

Equipment	For plants handling--			
	2,000 gal. milk & 400 gal. ice cream		200 gal. milk & 40 gal. ice cream	
	Cost[1]	Space required	Cost[1]	Space required
	Dollars	Sq. ft.	Dollars	Sq. ft.
1 mixing cone ($225) and pump ($270)	495	7	---	---

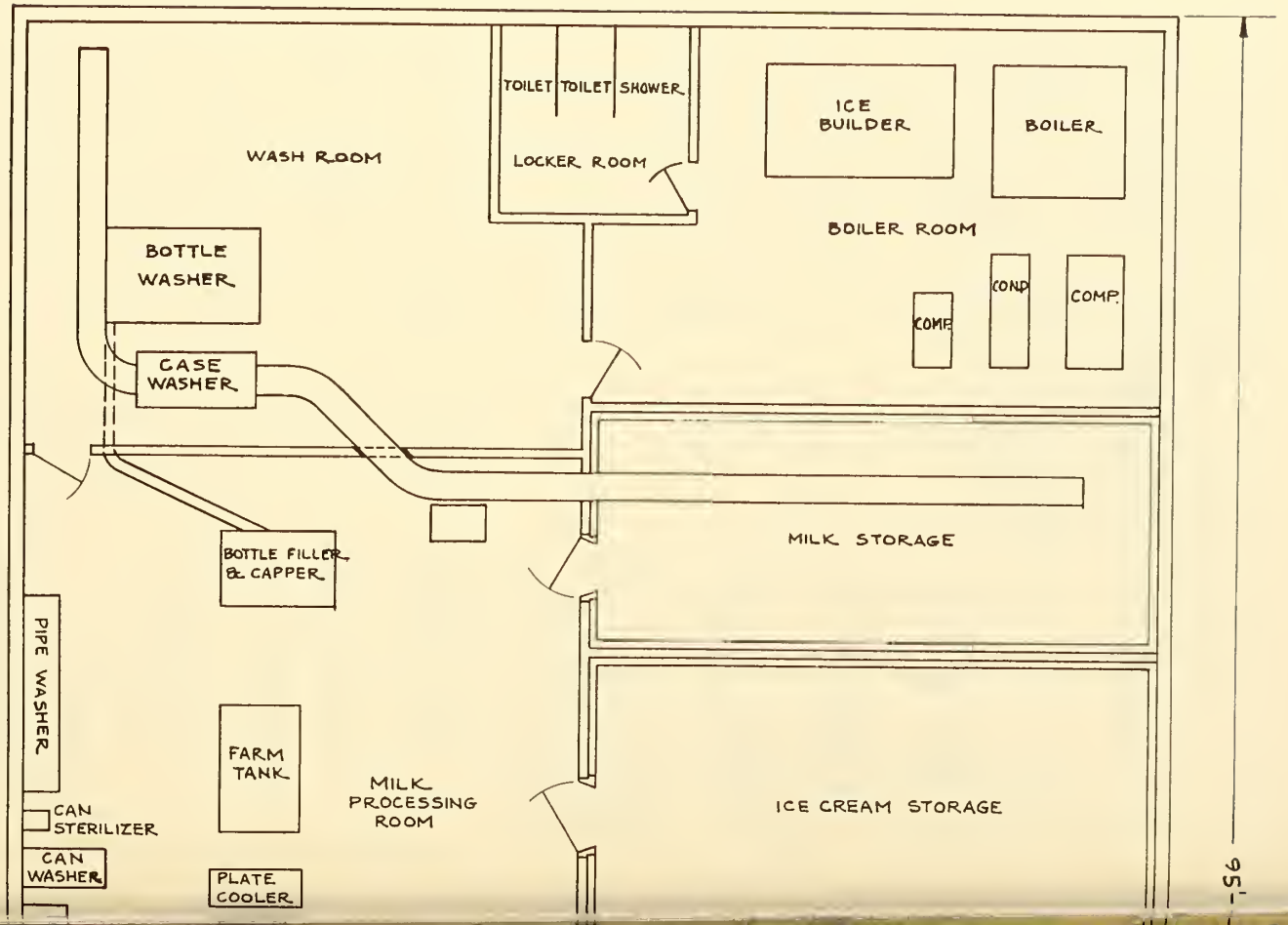
See footnotes at end of table.

[4] "The Ice Cream Industry," by Turnbow, Tracy, & Raffetto, 2nd ed., p. 286, McGraw-Hill, 1947.

Equipment	For plants handling--			
	2,000 gal. milk & 400 gal. ice cream		200 gal. milk & 40 gal. ice cream	
	Cost[1]	Space required	Cost[1]	Space required
	Dollars	Sq. ft.	Dollars	Sq. ft.
3 200-gal. pasteurizing vats with airspace heater	7,425	108	---	---
1 100-gal. pasteurizing vat (airspace heater and cooling spray ring)	---	---	1,600	11
1 200-gal. farm tank (cold milk storage). .	2,325	29.0	---	---
1 150-gal. farm tank (cold milk storage). .	---	---	1,230	29
1 400-gal.-per-hour 2-stage homogenizer.	4,935	12	---	---
1 100-gal.-per-hour 2-stage homogenizer.	---	---	3,200	8
1 400-gal.-per-hour plate cooler	2,585	10	---	---
1 6' x 6' walk-in refrig. storage. . . .	---	---	1,500	36
1 steam generator, 50 hp., automatic	4,100	49	---	---
1 steam generator, 18 hp., automatic	---	---	2,750	36
1 ice builder.	4,060	60	---	---
1 60-gal.-per-hour continuous ice cream freezer.	5,655	20	---	---
1 cup filler (hand operated).	850	16	850	16
1 soft serve ice cream freezer[2]	2,765	20	2,765	20

Equipment	For plants handling--			
	2,000 gal. milk & 400 gal. ice cream		200 gal. milk & 40 gal. ice cream	
	Cost[1]	Space required	Cost[1]	Space required
	Dollars	Sq. ft.	Dollars	Sq. ft.
1 counter freezer (2-1/2 gal. freezer, 40 gal. storage)	---	---	3,495	15
1 ice cream serving cabinet[2]	305	18	305	18
1 milk dispenser[2]	295	6	295	6
20 5-gal. dispenser cans (@ $10.50)	210		210	
1,000 tubes for dispenser can (@ 8-1/2¢)	85		85	
50 10-gal. milk cans (@ $11.00)	550		---	---
20 10-gal. milk cans (@ $11.00)	---	---		220
1 milk can washer (brush type)	410	9	---	---
1 can rinser, sterilizer	85	2	85	2
1 3-compartment stainless-steel wash sink	135	20	135	20
Stainless-steel sanitary piping and fittings (1-1/2")	1,100	---	759	---
1 stainless-steel pipe washing tank	465	21	---	---
12 nylon brushes for pipe washer	55	---	---	---
3 recording thermometers (@ $195)	585	---	195	---
3 indicating thermometers (@ $55)	165	---	55	---

Equipment	For plants handling--			
	2,000 gal. milk & 400 gal. ice cream		200 gal. milk & 40 gal. ice cream	
	Cost[1]	Space required	Cost[1]	Space required
	Dollars	Sq. ft.	Dollars	Sq. ft.
3 airspace thermometers (@ $35)	105	---	35	---
Compressor for milk storage room (5 tons)	1,000	8	---	---
Compressors for ice cream hardening room (15 tons)[3]	3,000	18	---	---
If glass bottles and not paper cartons are used as milk containers, the following equipment would also be required:				
1 rotary filling and capping machine (50 bot. per/min.)	1,875	24	---	---
1 hand filling and capping machine	---	---	450	10
1 case washer (10 cases per/min.)	1,170	19	---	---
1 soaker-type bottle washer (50 bot. per/min.)	4,705	41	---	---
Conveyor[4]	1,500	---	---	---
Miscellaneous and installation charges	5,000	---	2,000	---
Initial supply of glass bottles (7 times the daily number filled) (100 gross qts., 400 gross pts., 400 gross 1/2 pts.)	7,500	---	---	---


TOILET
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SHOWER
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LOCKER ROOM
ICE BUILDER
BOILER
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BOTTLE WASHER
COMP.
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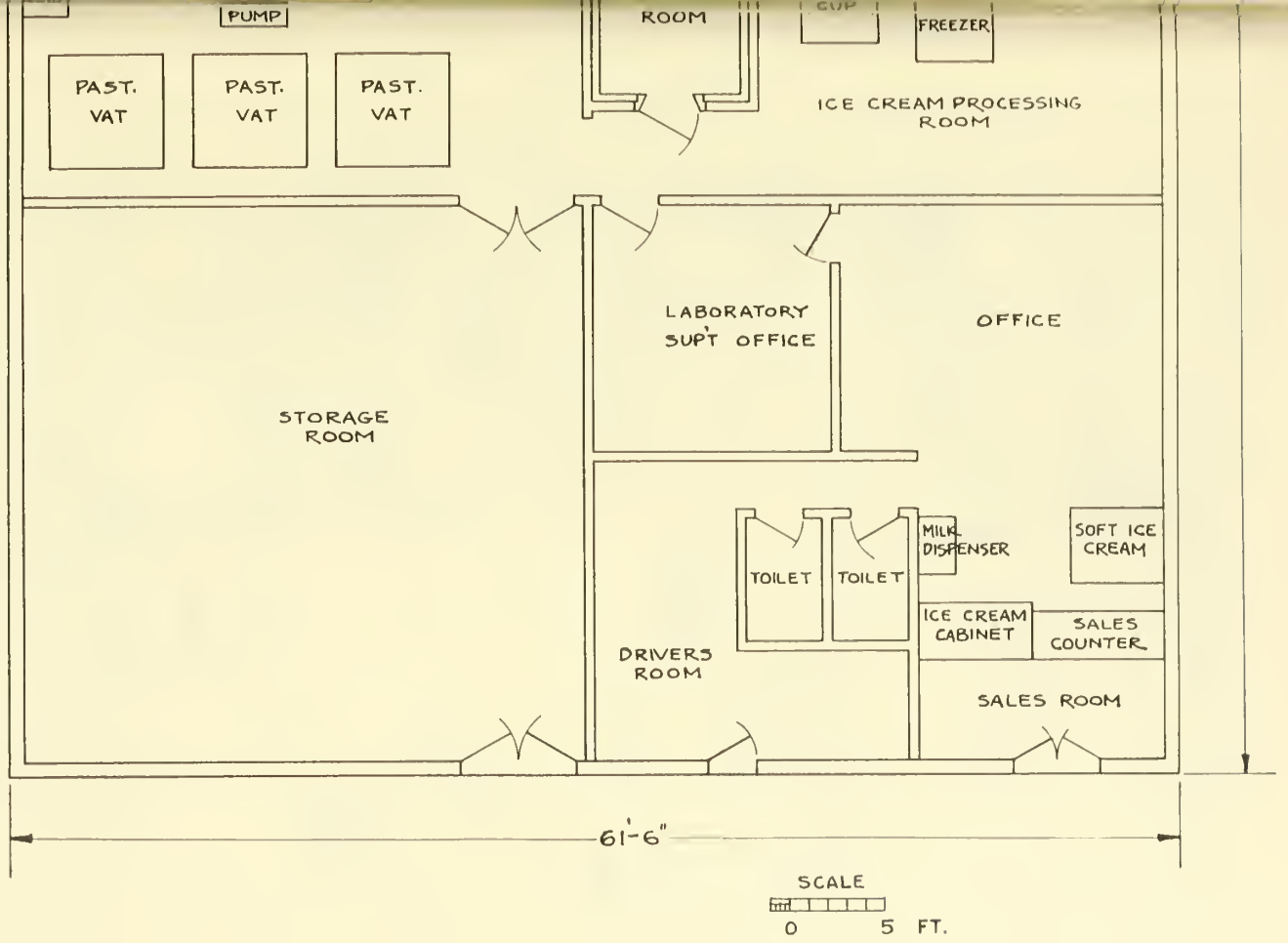
CASE WASHER
MILK STORAGE
BOTTLE FILLER & CAPPER
PIPE WASHER
FARM TANK
MILK PROCESSING ROOM
ICE CREAM STORAGE
CAN STERILIZER
CAN WASHER
PLATE COOLER
95'-



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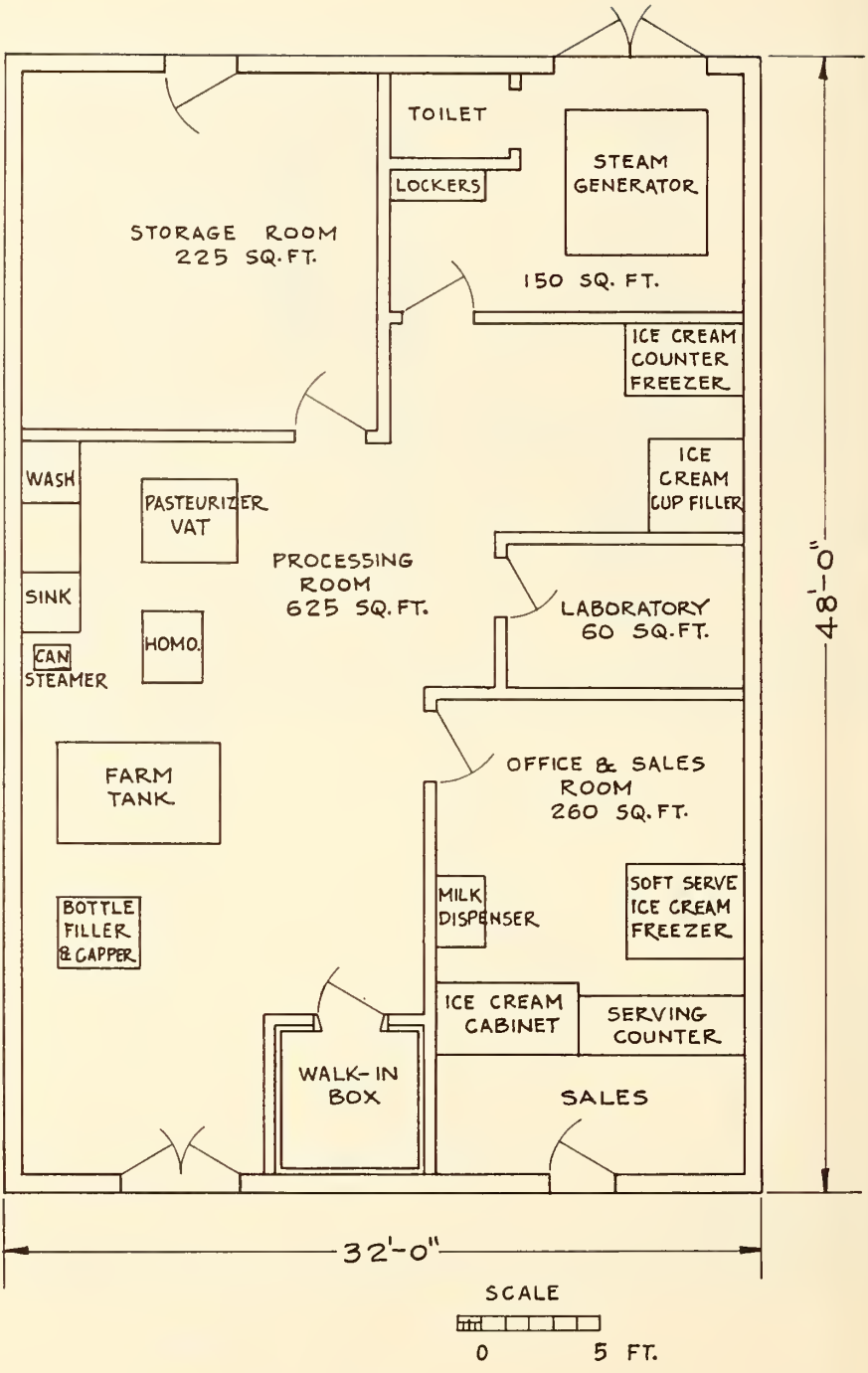

By F. P. Hanrahan

Equipment	For plants handling--			
	2,000 gal. milk & 400 gal. ice cream		200 gal. milk & 40 gal. ice cream	
	Cost[1]	Space required	Cost[1]	Space required
	Dollars	Sq. ft.	Dollars	Sq. ft.
Initial supply (3 months) aluminum closures, 1,660,000 (@ $1.75 per thousand)	2,900	---	---	---
Initial supply glass quart bottles, 30 gross	---	---	330	---
Initial supply paper bottle caps (3 months), 54,000 (@ $1.10 per thousand)	---	---	60	---
Optional - hardening room controls	7,000	---		---
Optional - water treatment equipment	3,000	---	800	---
Optional - pressure-type bottle washer (3 compartment).			1,500	
Total cost . . .	78,395		24,900	
Total sq. ft. . .		529		227

[1]Plus crating for export, freight, insurance, and handling cost.

[2]For sales room.

[3]Desirable for ice cream hardening room are automatic defrosters, automatic controls, blower, cooling tower, and similar equipment, which would probably make the total cost of equipment about $10,000.

[4]Cost of conveyor from bottle washer to filler: about $32 per foot, with $144 additional for a 90-degree-angle turn or $364 for a revolving plate and $395 for power drive. Cost of stainless-steel canopy or hood for conveyor: about $15 per foot. All orders for conveyor must be accompanied by layout showing height of conveyor at washer and at filling table, also locations of turns and power units, and whether accumulating table is to be used.

Bottles or Cartons

The initial supply of glass bottles and bottle closures is based on the assumption that the 2,000 gallons of milk processed per day would all be bottled (with the exception of a few cans for use in the milk dispenser in the sales room), and that one-fourth of the supply would be quarts, one-half, pints, and one-fourth, half pints. As shown in the preceding table, an initial supply of 7 times the daily number of bottles filled would have to be stocked at the start — 100 gross of quarts @ $11.00, 400 gross of pints @ $9.00, and 400 gross of half pints @ $7.00 = $7,500.00. In the smaller plant, presumably three-fourths of the milk handled would be in quart bottles. This would require an initial supply of 30 gross at a cost of $330. Assuming 30 trips per bottle, 3 times the number required daily should be ordered every 3 months. A 3-month supply (90 days) of glass bottles for the larger plant would cost $3,125 and the closures would cost $2,900, making a total cost of $6,025. For the smaller plant the cost would be $143 for bottles and $60 for caps, making a total of $203.

The use of paper milk cartons in the 2,000-gallon plant instead of glass would increase the equipment cost (including a 3-month supply of paper cartons) by approximately $14,472. The filling and sealing machine for the paper cartons would cost approximately $5,950 and a 3-month supply of cartons approximately $27,000; the total, $32,950. This equipment and the cartons would replace the glass bottle filler, bottle washer, conveyor, initial supply of glass bottles, and 3-month supply of bottle closures, which total $18,480.

If paper bottles were used in the larger plant, the number of bottles required to be stocked would depend upon the availability of supply and the discount obtainable on a larger order. At least a 3- or 4-month supply should be kept on hand, and replacements should be ordered at least bimonthly.

The cost of paper bottles would be approximately as follows, depending on the number ordered:

	Dollars per thousand
Quarts	20.00 to 22.00
Pints	17.00 to 17.75
Half pints	14.00 to 14.75

A 3-month (90 days) supply would probably cost about:

	Dollars	Dollars
Quarts	2 x 90 x 22.00 =	3,960
Pints	8 x 90 x 17.50 =	12,600
Half pints	8 x 90 x 14.50 =	10,440
Total		27,000

Room Size

Since the size of the processing room should be 5 times the floor space required by the equipment, the milk processing room for the 2,000-gallon plant should provide about 1,225 square feet of space and for the 200-gallon plant, 735 square feet.

The ice cream freezer room for the larger plant should have about 330 square feet.

The bottle washing and bottle storage room for the larger plant should be large enough to accommodate the equipment plus an area equal to that of the milk cold storage room.

For a dry storage area, a good size has been found to be about 1/4 of the total plant area. In this case it would be about 960 square feet for the large plant and 190 square feet for the smaller one.

The boiler and engine room for the steam generator, ice builder, and compressors will require a space of about 600 square feet for the larger plant and 120 for the smaller one.

The milk cold storage room should be about 360 square feet for the larger plant.

The ice cream hardening room for the larger plant (50 percent specialties, 50 percent bulk) should be about 480 square feet.

Ingredients Required

To make 2,000 gallons of recombined milk testing 3 percent milk fat and 9.0 solids not fat daily, will require 516 pounds of anhydrous milk fat and 1,548 pounds of nonfat dry milk. A 2-month supply (60 days) would require 30,960 pounds of anhydrous milk fat and 92,880 pounds of nonfat dry milk.

To make 400 gallons of ice cream mix for use in making hardened ice cream containing 10.0 percent milk fat and 11.0 percent milk solids not fat daily, will require 372 pounds of anhydrous milk fat and 409 pounds of nonfat dry milk. A 2-month supply (60 days) would require 22,320 pounds of anhydrous milk fat and 24,540 pounds of nonfat dry milk. If a soft ice cream is to be made, a mix containing 6.0 percent milk fat and 12.0 percent milk solids not fat would be desired. To make 400 gallons of such a mix daily would require 223.0 pounds of anhydrous fat and 446.0 pounds of nonfat dry milk. A 2-month supply (60 days) would require 13,380 pounds of anhydrous milk fat and 26,760 pounds of nonfat dry milk.

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